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ERTS-A DATA AS A TEACHING AND RESEARCH TOOL IN THE
DEPARTMENT OF GEOLOGY

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15. Supplementary Notes ERTS-1 Project, GSFC No. 110-11 Principal Investigational, Donald Grybeck, GSFC ID No. UN 602 One of 12 ERTS-1 projects conducted by the University of Alaska.			
16. Abstract <p>The project was an attempt to integrate ERTS-A data into teaching introductory, specialized, and graduate courses in the Department of Geology, University of Alaska. This data was to be utilized principally through a specially selected, high quality collection of black and white, and color 9.5 mosaics of the state of Alaska. In completing these tasks, the data accumulated has proved highly useful in a variety of ways including: (a) discussions of the uses and availability of ERTS imagery, (b) as a medium for talking about and showing various areas of Alaska, (c) in discussing geology in general, and (d) as an aid in doing research and as possible research topics themselves. Use of ERTS imagery in Geology proved highly successful and its use is now an integral part of many courses.</p>			
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PREFACE

Objectives of Project:

1. Collection of a selected set of ERTS imagery for Alaska
2. The preparation of a mosaic or mosaics of Alaska utilizing ERTS-A imagery.
3. Integration of the imagery and the mosaics into teaching of geology and related sciences at the University of Alaska.

Scope of the work:

The objectives of the project were carried out.

Results:

Both the collection of ERTS-A imagery and the numerous mosaics constructed quickly proved exceedingly useful in teaching geology and especially Alaskan geology. The project entered the utilization stage almost immediately.

Recommendations:

1. That ways of disseminating selected ERTS imagery to teachers on a non-project basis be investigated more fully.
2. That a selected collection of 35mm slides be produced which can be disseminated widely for use in teaching. This collection would be mainly of geologic features that are especially well shown or uniquely shown on ERTS imagery.

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ERTS-A DATA AS A TEACHING AND RESEARCH TOOL

IN THE DEPARTMENT OF GEOLOGY

Introduction

The general purpose of this project was to utilize ERTS-A imagery in teaching. This was to be accomplished through a collection of selected ERTS-A imagery of Alaska and by preparation of a mosaic of ERTS-A prints of all of Alaska. No specific data analysis goal was envisioned; rather the project was to consider the variety of types of data analysis that might be used routinely in teaching and research and to consider how ERTS-A imagery could be used as an informational media in teaching and public service.

Data Acquisition

The project relied almost entirely on NASA-supplied, black and white, and color prints. A considerable portion of the time spent in the project involved going through the files of Alaskan imagery in the Geophysical Institute as well as in various NASA indices. The prints to be ordered were then selected on the basis of image quality, cloud cover, depiction of geology, need to get total coverage of the state, and the desire to restrict the collection to the best material for any given area. This selection resulted in three Data Requests:

- a. February 26, 1973: 156 images - 2 each in 9.5 paper

print format of MSS Bands 6 and 7, and MSS color.

b. May 25, 1973: 133 images - 2 each in 9.5 paper print format of MSS Band 7 (Color prints did not seem appropriate at this time due to snow cover)

c. October 4, 1974: 219 images - 2 each in 9.5 paper print format in MSS Band 7; 141 images - 2 each in MSS color, 9.5 paper print format.

As a matter of general interest, the most useful imagery (at least for teaching) was obtained during the period from August to November 1972. The imagery obtained in the Spring of 1973 was somewhat obscured by snow - the black and white prints were satisfactory in some cases but the color imagery was not worth getting. The images obtained during the late Spring and early Summer of 1973 were becoming progressively better for interpretation of geology as the snow melted. Unfortunately, the ability to order prints through this project terminated on June 30, 1973.

Data Organization

The prints received were trimmed on two sides and filed by image number in manila folders. Since ease of access was to be a primary characteristic of this collection, three indices were prepared that showed the outline of the individual images on a 1:2,500,000 map, Alaska Map E of the U.S. Geological Survey - the three indices roughly separated Fall 1972, Spring 1973, and early summer 1973 imagery.

When enough prints had accumulated, some thought was given to preparation of the mosaic of Alaska. It was immediately obvious that a mosaic of the whole state of Alaska could not be prepared in color (and this remains true) because of lack of color match in NASA prints mainly due to seasonal change but also because of processing variations. However, it was also readily apparent that a black and white, semi-controlled mosaic could be readily prepared - if the coverage became available. The advent of Log-E printing gave a color and density match that varied from excellent to satisfactory and the distortion was well within workable limits. Accordingly a mosaic that included about 40% of the state of Alaska was completed utilizing Band 6 imagery. This involved about 75 prints and included the biggest area of the state that was covered by anything near continuous coverage. There was no particular problems in constructing this mosaic using standard techniques. While this effort was considered to be mainly a test, the resultant mosaic was quite satisfactory and has been used widely for teaching and illustration. A number of other, smaller black and white mosacis were constructed of limited areas. However, when the ability to order NASA prints terminated on June 30, 1973, there was still not sufficient coverage to prepare a quality mosaic of the whole state (especially one that required sufficient quality to show geology). Not only were there holes in a number of areas but most of Southeastern Alaska still was not covered by even remotely useable images (and there was never any serious thought

that the Aleutians could be covered with anything near continuous imagery even over a period of years). The primary reason for this lack of coverage was cloud cover. Thus the construction of the mosaic of the whole state of Alaska was not completed during the project period although almost all of it has been covered in smaller mosaics. However, the preparation of the Alaskan mosaic has not been abandoned; presently it is actively being worked on. Through the efforts and support of the Geophysical Institute, the principal investigator, and other ERTS investigators, almost all of the holes have been filled in with imagery that became available subsequent to this project. Tentatively, the complete mosaic of the state will become available in the Summer of 1974 - although we are still trying to find or waiting for images that cover the few remaining holes or replace very poor images.



In spite of the fact that MSS color prints could not be compiled into a mosaic of the whole state, smaller color mosaics were readily prepared. The color match along a flight line, and not infrequently along successive flight lines, was quite satisfactory. And indeed, these smaller color mosaics were the most spectacular and useful of the teaching aids developed in the project. Fifteen of these smaller mosaics were prepared in MSS color that involved 3-12 prints each and about 50% of the state of Alaska is included in these mosaics.

Figure 1 shows the extent of the mosaics prepared during this study.


Figure 1

ERTS-A MOSAICS OF ALASKA

PREPARED FOR USE IN TEACHING

-  Black and White Mosaic
-  Color Mosaic

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Work done under NASA Contract NAS5-21833

Data Utilization

The ERTS imagery was utilized in teaching in a variety of ways:

- a. In discussions, both formally and informally, on what the ERTS satellite is, what the prints are (especially what the red in the MSS color prints is and what all the numbers are!), how one finds and orders the imagery, and some basics of interpretation of the prints, and often a discussion of the other more sophisticated techniques that are readily useable on this campus.
- b. As a medium for talking about areas in Alaska - often used in conjunction with various other maps, aerial photographs, etc.
- c. In a wider context, in discussing geology in general, e.g. in illustrating the appearance of basalts or granitic batholiths, spits, deltas, etc.
- d. In various types of research topics including theses and faculty research projects where regional information is needed about a little known area of Alaska.
- e. Simply as strikingly vivid views of Alaska in talks oriented to introductory courses or the general public.

Most frequently, a number of the various approaches listed above were used in conjunction with one another.

It very quickly became apparent that the available formats of the imagery were not really convenient for most teaching purposes, i.e.

to large groups. Accordingly, 35 mm color slides were prepared of the more useful prints. This was done by the Principal Investigator using a single lens reflex camera and photofloods with relatively little effort and quite satisfactory results (some of these slides were shown at the October 29, 1973 presentation for NASA at Goddard Space Flight Center). A collection of more than 200 color slides representing both black and white color prints is now filed with the prints themselves.

In general, it was found that the ERTS imagery was best used in conjunction with other maps and aerial photographs for most teaching purposes and almost all public-service presentations. It was also convenient to use them in conjunction with color slides taken on the ground - but this is obviously limited to what the user has been able to accumulate.

The imagery has been used in the following courses (some a number of times):

- a. Geology of Alaska (Graduate Course)
- b. Theories of Ore Deposits (Graduate Course)
- c. Economic Geology
- d. Structural Geology
- e. Earth Science and Human Affairs
- f. Geography of Alaska
- g. Map and Air Photo Interpretation
- h. Frontiers of Geology (Graduate Course in Anchorage)

....and has been used wholly or in part to talk to or about:

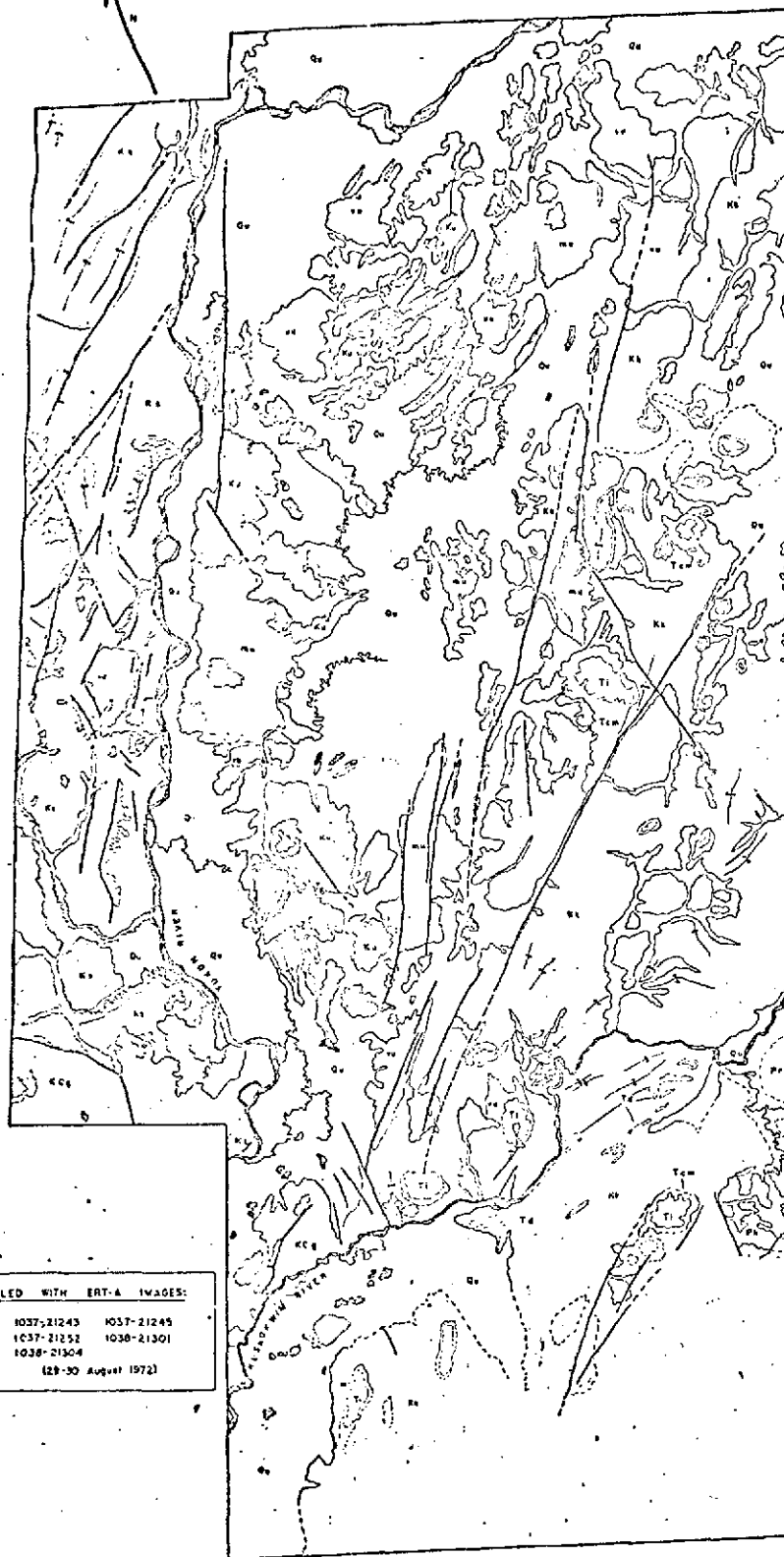
- a. "Ert's Imagery in Geology" (Geology Seminar)
- b. "Geology of Alaska" (a standardized 1-hour presentation by the principal investigator about 15 times a year)
- c. Various High and Grade School classes
- d. Yukon-Tanana Historical Society
- e. American Institute of Mining, Metallurgical, and Petroleum Engineers
- f. Exhibits in conjunction with "Engineer's Open House" by the students

....as well as many hours spent in talking about the mosaics and imagery with geologist and students that heard about them or were merely passing by in relation to interests that varied from mountaineering to ore deposits to fossils to.....

I still have the distinct impression that the vast majority of potential users, both professional and non-professional, have little if any idea of the availability and uses of ERTS imagery - although some that are aware of it have rather exaggerated ideas of what it can do. This situation has improved somewhat in recent months by the Kodak advertisements in the various scientific journals.

The graduate course, Geology of Alaska, in particular relied heavily on ERTS imagery this year. It was used in the initial stages primarily as a rapid way of familiarizing the students with the geology and geography of Alaska. It was then used somewhat more specifically in discussing given areas, and finally, each student used the ERTS imagery in conjunction with the available geologic data to compile an up-dated geologic map of a specific region. Figure 2 (on the following page) is a reduced copy of a typical effort; the original

GEOLOGY OF THE YUKON-KUSKOKWIM RIVERS REGION



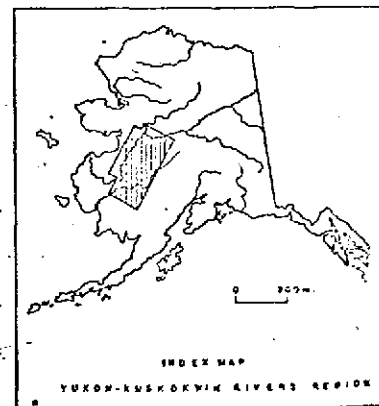
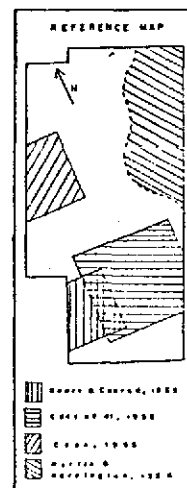
COMPILED WITH ERT-A IMAGES:

1037-21243 1037-21245
1037-21252 1038-21301
1038-21304
(29-30 August 1972)

0 10 20 30 40 50 60 70 80 90 100
SCALE 1:100,000

EXPLANATION	
SURFICIAL DEPOSITS	
Qa	Quaternary
BEDDED ROCKS	
W	Washburn Group
Ks	Kuskokwim Group
Kc	Cretaceous
NCB	Neogene
Pa	Paleozoic
INTRUSIVE IGNEOUS ROCKS	
Ta	Tertiary
Td	Dike rocks
METAMORPHIC ROCKS	
Tm	Tertiary
MC	Metamorphic
OTHER FEATURES	
Faults, dashed where inferred	
Geologic, dashed where inferred	
Anticline fold axis	

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GEOLOGY COMPILED BY ROBERT M. THOMPSON 1971

Figure 1: Example of a Geologic Map prepared by a Student utilizing ERTS-A Imagery

was prepared in color at about 1:1,000,000 on transparent drafting film to be used over one of the MSS color mosaics. It and others are now used for a display in the Geology Department.

It was also found convenient to prepare a list of the most definitive and useful ERTS images for use in the various courses and especially for quick reference by other teachers who wished to find good illustrative material without going through the whole collection. This listing is reproduced as Appendix A and gives the number of prints as well as the geologic features that are so well shown on them. Almost all are also on 35 mm color slides.

Although no specific data analysis goal was part of this project, it is a rare geologist that did not try to interpretate the prints or mosaic. The project has led to a number of informal attempts at interpretation of various areas - in particular by students as part of their thesis work. In addition, a number of geologist from mining companies have examined the material in some detail. Two spent considerable time in examining them and indicated that they would order their own sets of imagery.

Although the project is formally ended, the use of this material should, if anything, increase in the future. They are a permanent portion of a number of classes and new uses are continually being found for them. For instance, there is considerable interest on both the part of the U.S. Bureau of Mines and the Alaska Division of Geological and Geophysical Surveys to use ERTS imagery and the mosaic that is being prepared as a base and guide to define the ore deposits of Alaska.

Conclusions

The almost immediate result of this project was that ERTS-A imagery proved to be highly useful in both teaching and research in geology - and indeed, the material will prove just as useful far into the future. The ability to get a "real vision" view of Alaska and its geology is unique to ERTS imagery.

Recommendations

1. That NASA investigate the possibility of preparing a set of 50-100, 35 mm color slides that illustrate the main and/or typical features of the geology of the conterminous United States as seen on ERTS imagery.
2. Investigate methods to make ERTS imagery conveniently available to teachers. This should probably be handled on a non-project basis and should emphasize quality imagery that is readily interpreted by students and cover a wide range of geologic examples.

APPENDIX A

SELECTED ERTS-A IMAGERY OF ALASKA WITH GEOLOGIC ANNOTATION

Note: The most useful geologic map to use as a reference is the Alaskan portion of King's (1969) "Tectonic Map of North America".

Image Number

- | | |
|------------|---|
| 1006-21510 | <u>Barrow area, Northern Alaska</u>
a. Oriented lakes, Arctic coastal plain |
| 1009-22092 | <u>York Mountains, Seward Peninsula</u> |
| 1009-22095 | a. Ordovician Port Clarence Limestone remains white - does not support vegetation.
b. Note hornfelsed zones (brownish on color prints) near Sn-bearing granite stocks
c. Spits |
| 1018-21191 | <u>Central Kuskokwim Area, Southwestern Alaska</u> |
| 1018-21193 | a. Mesozoic-Tertiary granitic stocks stand out distinctly; the albite rhyolite sills can be found with some study. |
| 1018-21200 | b. The Denali Fault (here often called the Farewell Fault) and the Iditarod Fault stand out prominently
c. The Tikchik Lakes in 1018-21200 are seen to be controlled by:
1. the continuation of the Denali Fault
2. the glaciers draining to the east; and their moraines are nicely shown |
| 1019-19430 | <u>Juneau area, Southeastern Alaska</u>
a. Many linears well defined
b. Note "plumes" of silt-laden water at mouth of the glacial streams. |
| 1020-19480 | <u>Whitehorse area, Yukon, Territory</u>
a. Alaska Highway obvious
b. Plutons in vicinity stand out distinctly. |
| 1026-20211 | <u>Eagle-Dawson area, East-central Alaska</u>
a. Tintina Fault - which is not very distinct in this image in spite of its great offset.
b. The Paleozoic sedimentary section to the north of the Tintina Fault
c. Klondike placer gold district. |

Image Number

- 1026-20220 Wrangell Mountains, Southcentral Alaska
 a. Glaciers
 b. Kenecott Mine area
- 1030-20424 Romanzof Mountains, Northeastern Alaska
1050-20541 a. Digitations and folds at the east end of the Paleozoic core of the Romanzof Mountains
 b. Numerous unmapped linears (but can't identify most of the thrust faults as such)
 c. Deltas of the major river
- 1033-21020 Southern Alaska Range
 a. Glaciers; esp. examples of "galloping" glaciers
 b. Moraines and pitted outwash
- 1033-21022 Iliamna Lake, Southern Alaska Range
1033-21025 a. Extension (?) of Castle Mountain Fault through Long Lake
 b. Moraines, vicinity Iliamna Lake
- 1037-21231 Walker Lake Area, Central Brooks Range
1037-21234 a. Transition from southern foothills with prominent folds and faults to thrust belt in the heart of the Brooks Range, to fold belt in the northern foothills.
 b. Plutons north of Walker Lake fairly well shown.
- 1037-21234 Hughes-Hog River Area, Central Brooks Range
1037-21240 a. At least three well-defined intrusives. Esp. note Indian Mountain (where images overlap) - an eroded granite core surrounded by rim of hornfels hills which stand in relief around the granite.
 b. Numerous linears
- 1044-20212 Eagle-Dawson area, Yukon-Tanana Upland, Central Alaska
 a. Typical Yukon-Tanana terrain developed on medium to high-grade metamorphic rocks.
 b. Few "gray" plutons stand out.
 c. Northeast linears that range from obvious to obscure.
- 1046-22143 Point Hope area, Northwestern Alaska
1046-22145 a. Spectacular folds!
1045-22084 b. Transition between fold versus thrust fault belt is well marked.
1045-22091 c. Images to east are mainly in thrust belt but (in color) one of the large ultramafic bodies shows up well.

Image Number

- 1058-21423 Cape Denbigh to Yukon Delta, Western Alaska
1058-21421 a. Many prominent linears- some extending out onto
1058-21414 the Yukon Delta. Some are faults but some are also
 due to the northeast strike of the Cretaceous, etc.
 units.
 b. Smooth, unpitted surface associated with the Tertiary
 basalts (e.g., near St. Michael).
 c. Note the obvious circular (caldera??) structure about
 20 miles in diameter near Bonasila Dome in the big
 bend in the Yukon River.
- 1060-20111 Malaspina Glacier, Southcentral Alaska
 a. Piedmont Glacier
 b. Long-shore drift of silt-laden water flowing into
 the ocean from glacial streams
- 1061-20154 Dawson area, Yukon Territory
 a. Tintina fault well defined.
- 1061-20160 Upper Tanana River area-Wrangell Mountains; East-central
1061-20163 Alaska
 a. Complexity in Denali Fault-Totsunda Fault system
 north of the Wrangell Mountains
- 1063-20280 Chugach Range, Southcentral Alaska
1064-20334 a. Linears in Cretaceous Valdez Group
 b. Numerous glacial striations in the valleys
 c. Alaska Pipeline route from Copper Center to Valdez
- 1081-20272 Chicken to Mentasta Pass area, East-central Alaska
1081-20275 a. Linears in Yukon-Tanana Upland
 b. Denali-Totsunda Fault system vic. Mentasta Pass
- 1081-20281 Chitna-Cordova area, South-central Alaska
 a. Delta of Copper River (Black and White)
 b. Glacial striations in major valleys
- 1094-19595 Kluane Lake, Yukon Territory
 a. Continuation of Denali Fault in the Yukon Terr.
 b. Many linears.
- 1103-20495 Fort Yukon area, Central Alaska
1103-20493 a. Variations in Quaternary units in Yukon Flats.
- 1103-20502 Fairbanks area, Central Alaska
1103-20504 a. ENE and NE trending linears in Yukon-Tanana Upland
 b. Quaternary units and moraines extending out into
 the Tanana Valley from the Alaska Range

Image Number:

- 1103-20504 Talkeetna Mountains, Central Alaska
1103-20511 a. Denali Fault shown spectacularly.
b. Many other unmapped NE linears in Talkeetna Mtns.
c. Moraines at head of Little Delta River particularly striking.
d. Lithologic contact between (unmapped) rock units in western Talkeetna Mtns.
- 1103-20511 Anchorage area, Southcentral Alaska
1103-20513 a. Fault forming boundary of Chugach Mtns. just east
1103-20520 of Anchorage
b. Domal structure on southern Kenai Peninsula
c. Linears in Chugach Range
- 1103-20522 Kodiak Island, Southcentral Alaska
1103-20525 a. NNE striking linears; one of which forms boundary of large intrusive body in the center of the island.
- 1104-20563 Mt. McKinley area, Central Alaska
1104-20565 a. Denali Fault (which forms north face of Mt. McKinley)
b. Linears in the Kantishna Hills
- 1198-19380 Juneau-Baranof Island area, Southeastern Alaska
1198-19382 a. Striking linear features now often marked by fiords. Frequent conjugate sets of fractures.
- 1211-20501 Fort Yukon area, Central Alaska
1211-20504 a. Quaternary of the Yukon Flats and esp. alluvial fans
- 1227-20394 Big Delta area, Central Alaska
a. Faulted boundary of the Granite Mtns.
b. Alluvial fans and moraines in upper Tanana River.
c. Linears in Yukon-Tanana Upland
- 1240-21540 Nenana-Rampart area, Central Alaska
a. Linear; some are known faults and many coincide with recent epicenter alignments.
b. Quaternary deposits of the western Yukon Flats.
- 1311-21472 Selawik area, Northwestern Alaska
1311-21475 a. Delta of Kobuk River and the Selawik Flats.
1312-21531
1330-21525
- 1326-21291 Colville River, Northern Alaska
1326-21284 a. Delta of Colville River
b. Transition from Arctic Coastal Plain to Fold Belt on the northern side of the Brooks Range

Image Number:

1344-21283

1344-21290

1344-21292

Colville River, Northern Alaska

a. Delta of Colville River

b. Umiat Oil Field

c. Transition from:

a. Arctic Coastal Plain to

b. Fold belt along northern side of Brooks Range to

c. Thrust Belt in the Brooks Range.